

CS 414 – Multimedia Systems Design
Lecture 14 –
Quality of Service
Concepts(Part 2)

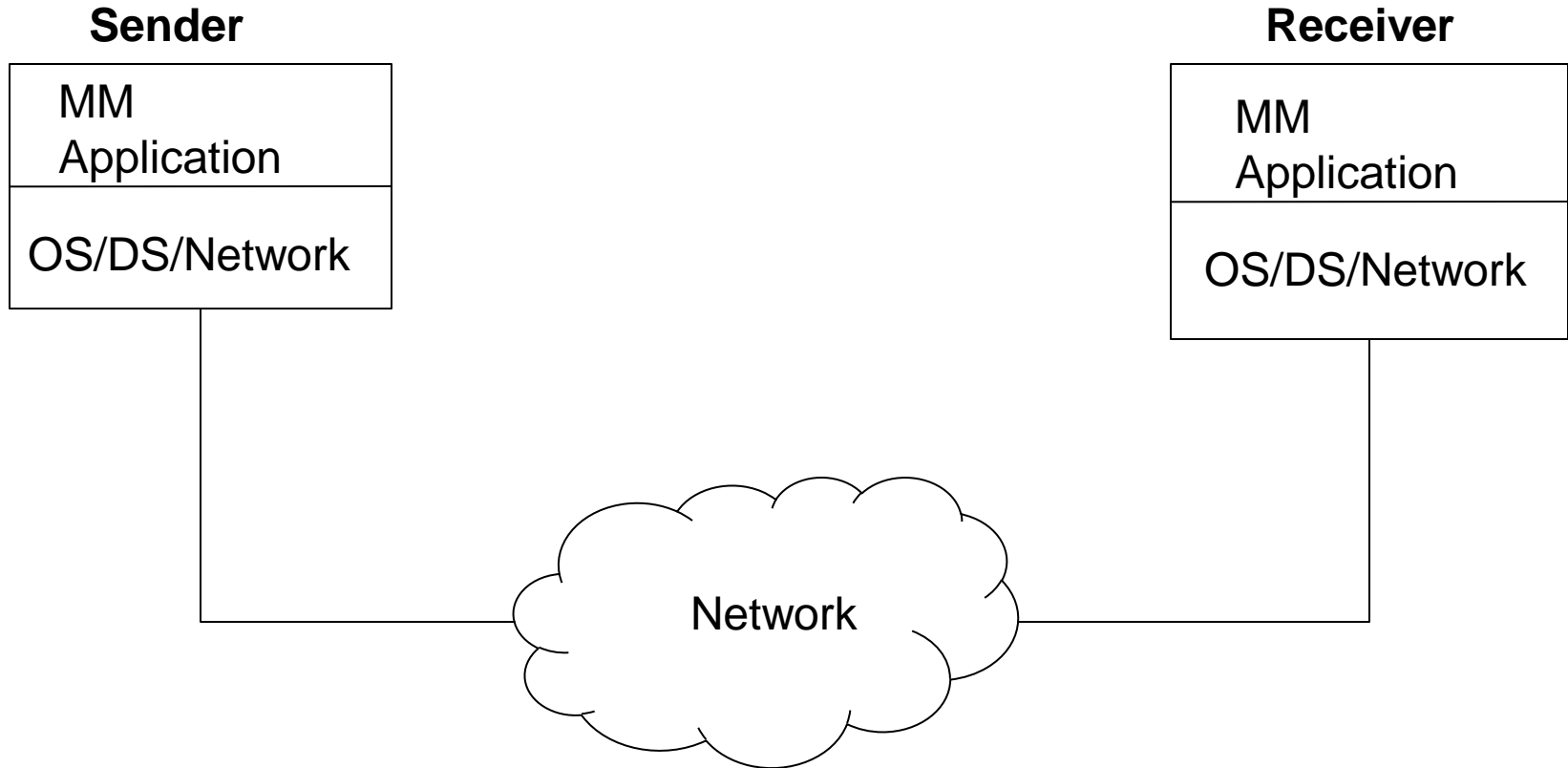
Klara Nahrstedt
Spring 2011



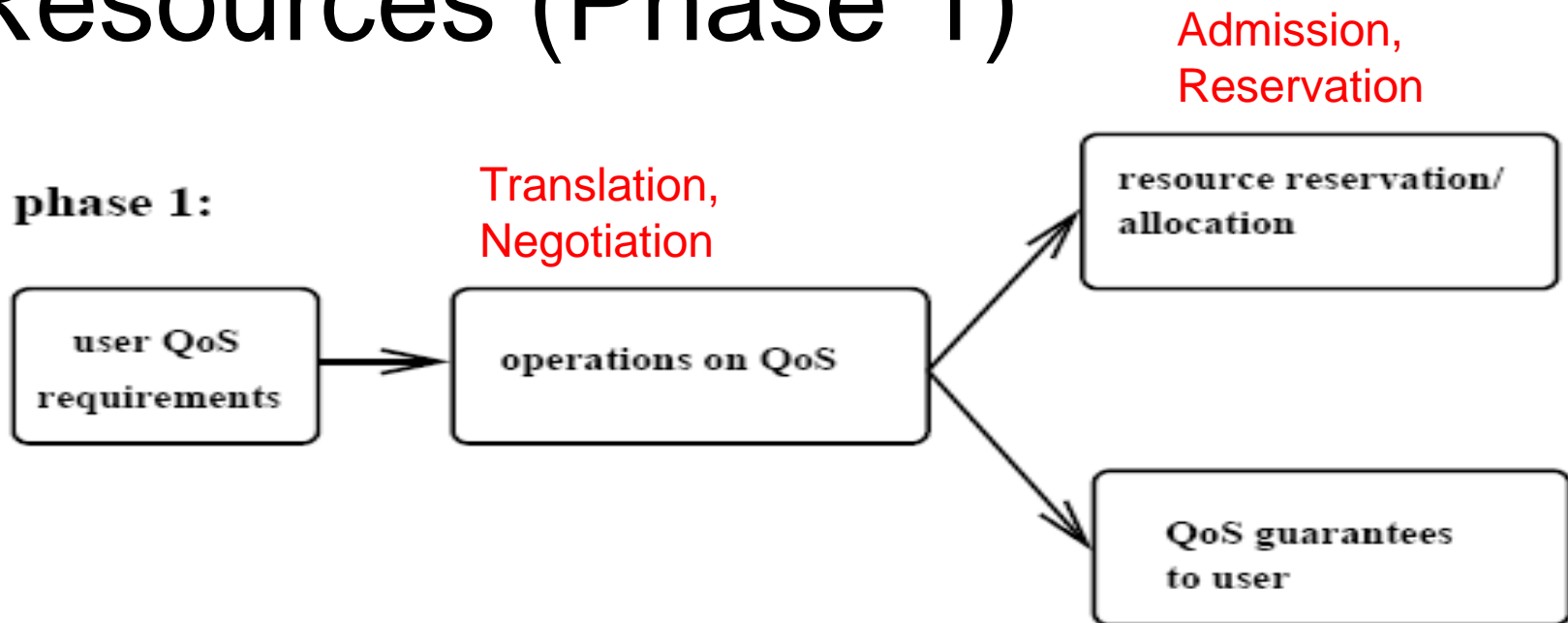
Administrative

- HW1 posted today, February 21
- HW1 deadline, March 2

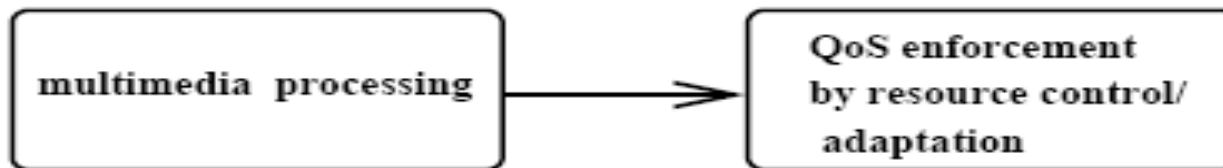
Multimedia System/Network



Relation between QoS and Resources (Phase 1)



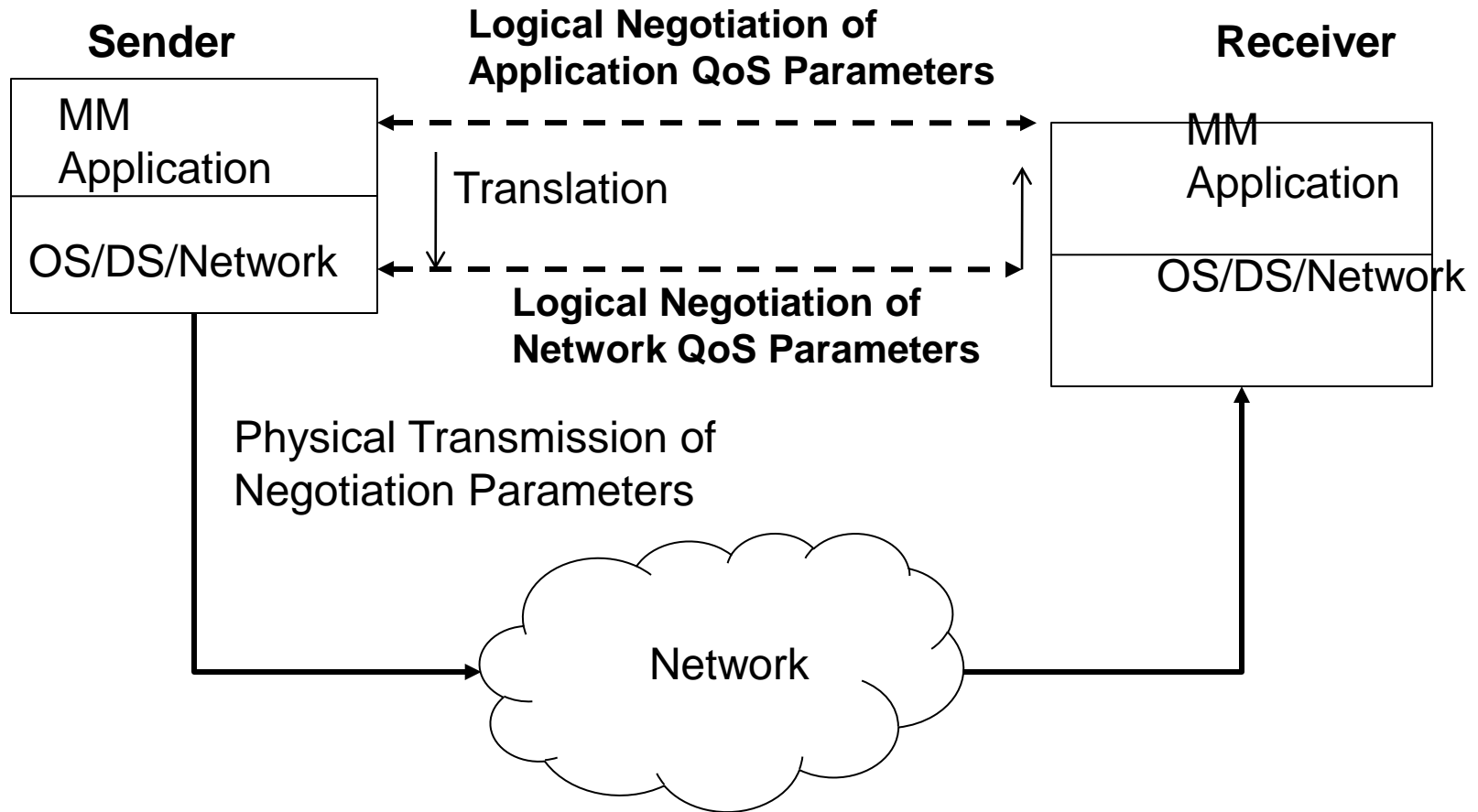
phase 2:



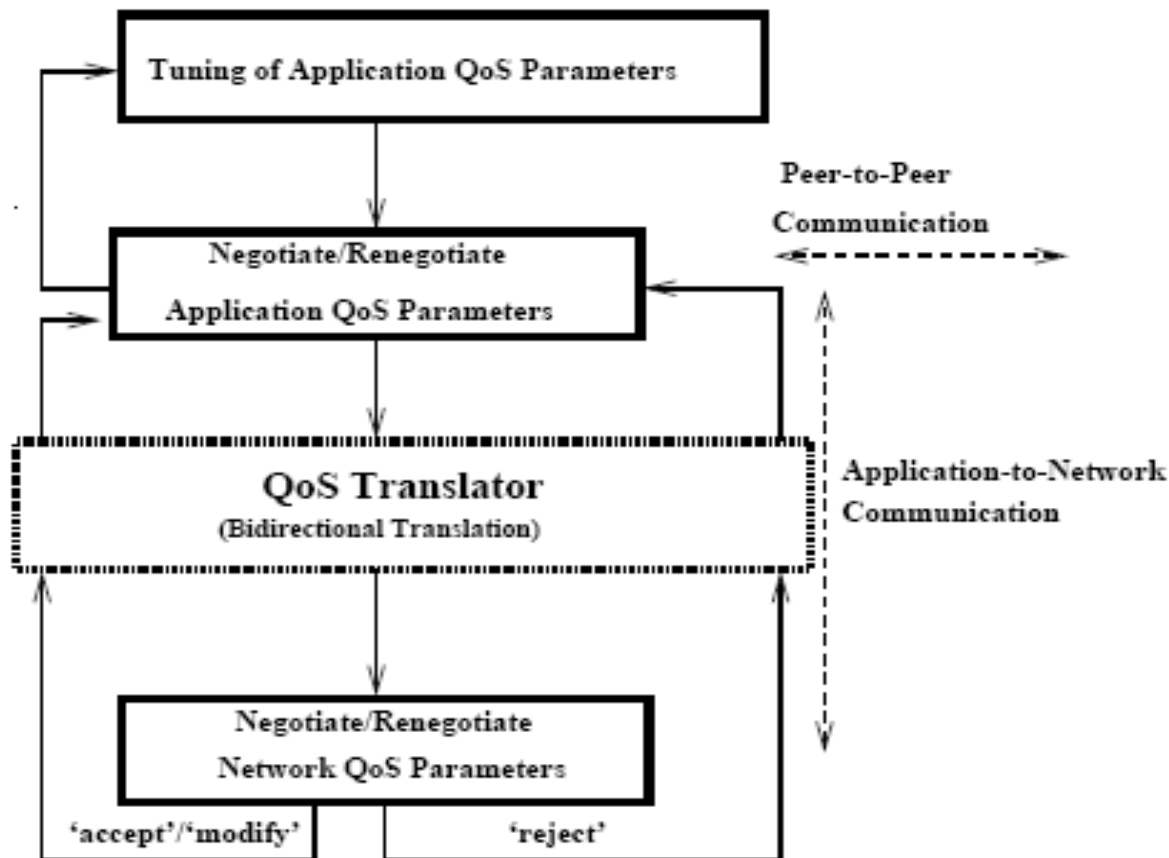
Phase 1: Establishment Phase (QoS Operations)

- **QoS Translation** at different Layers
 - User-Application
 - Application-OS/Transport Subsystem
- **QoS Negotiation**
 - Negotiation of QoS parameters among two peers/components

Phase 1: Connection Establishment



QoS Operations within Establishment Phase



User/Application
QoS Translation

Overlay P2P
QoS Negotiation

Application/Transport
QoS Translation

QoS Negotiation in
Transport Subsystem

Example

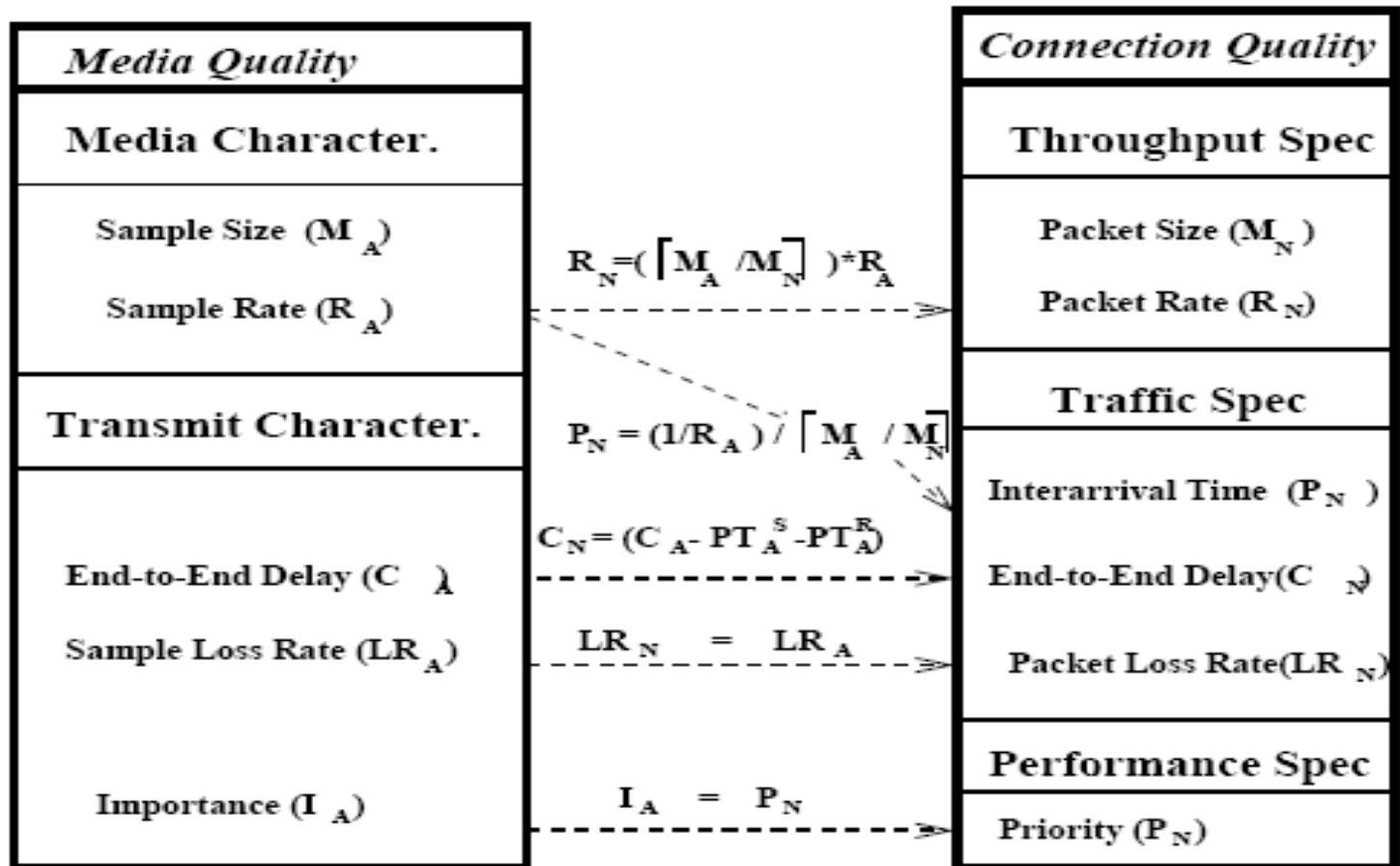
- Video Stream Quality:

- Frame size: 320x240 pixels, 24 bits (3 Bytes per pixel)
- Application frame rate R_A : 20 fps

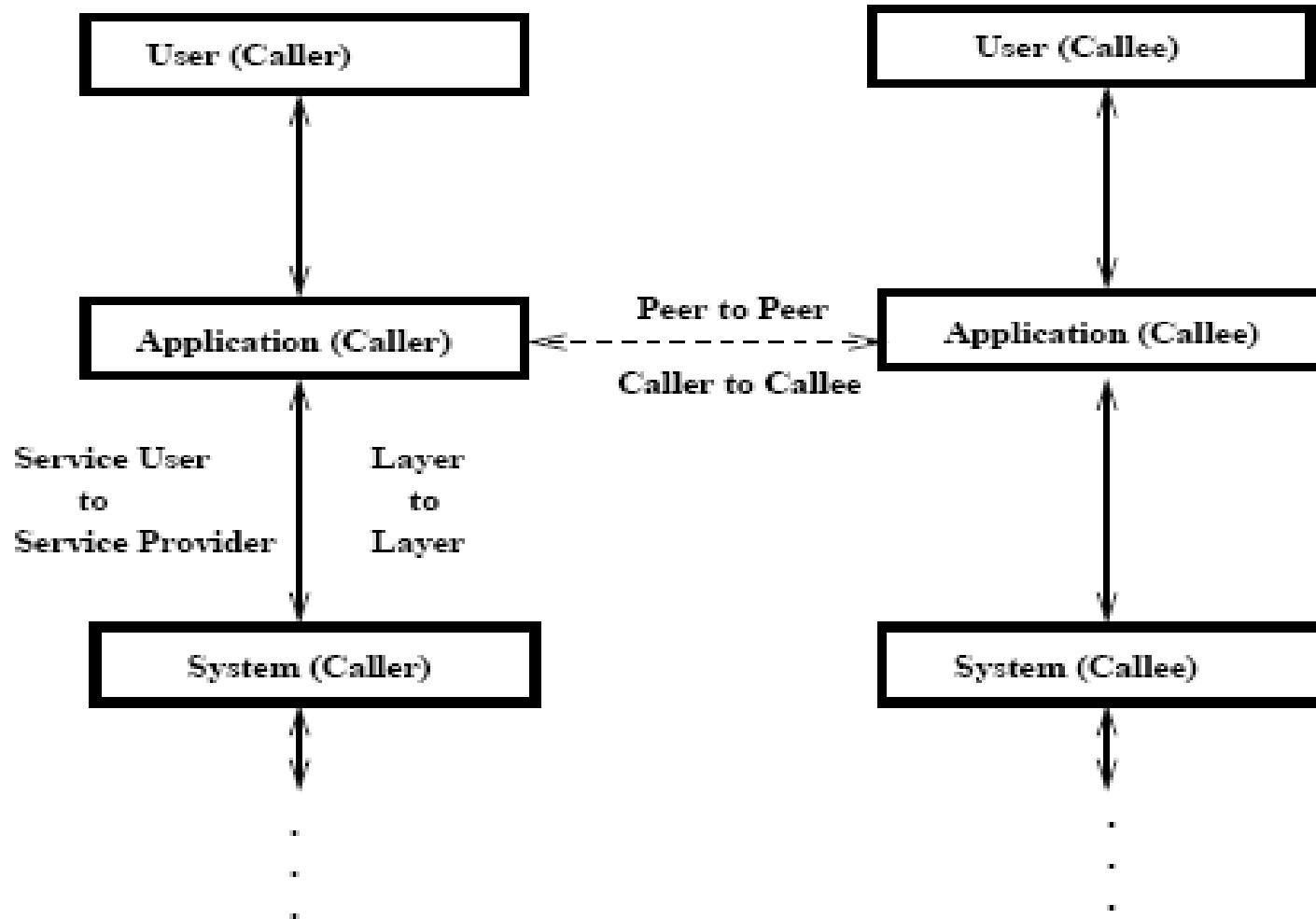
- Translate to Network QoS if

- Assume network packet size is 4KBytes
- Network packet rate (R_N):= $\lceil 320 \times 240 \times 3 \rceil$ bytes / 4096 bytes

Layered Translation (Example)



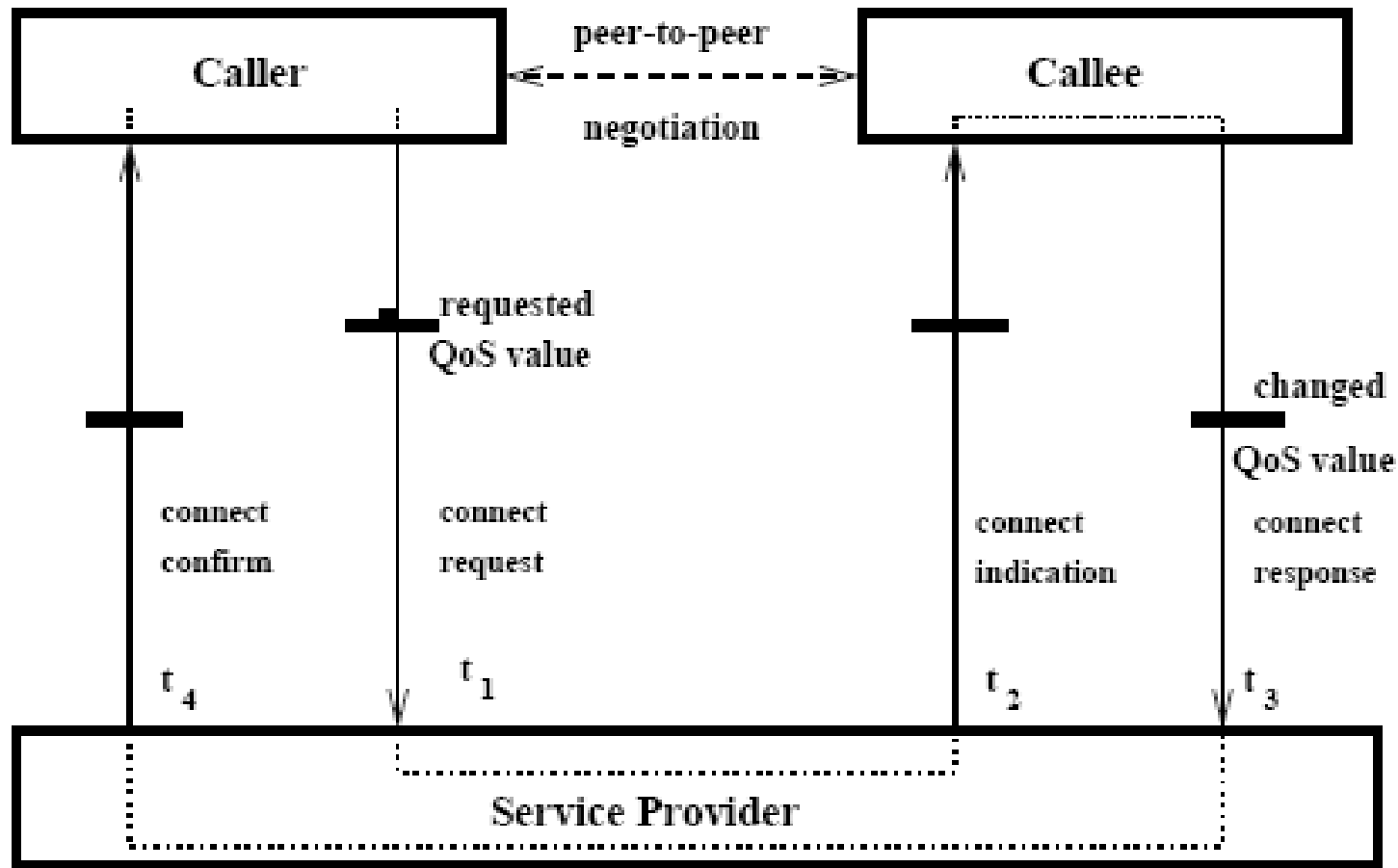
QoS Negotiation



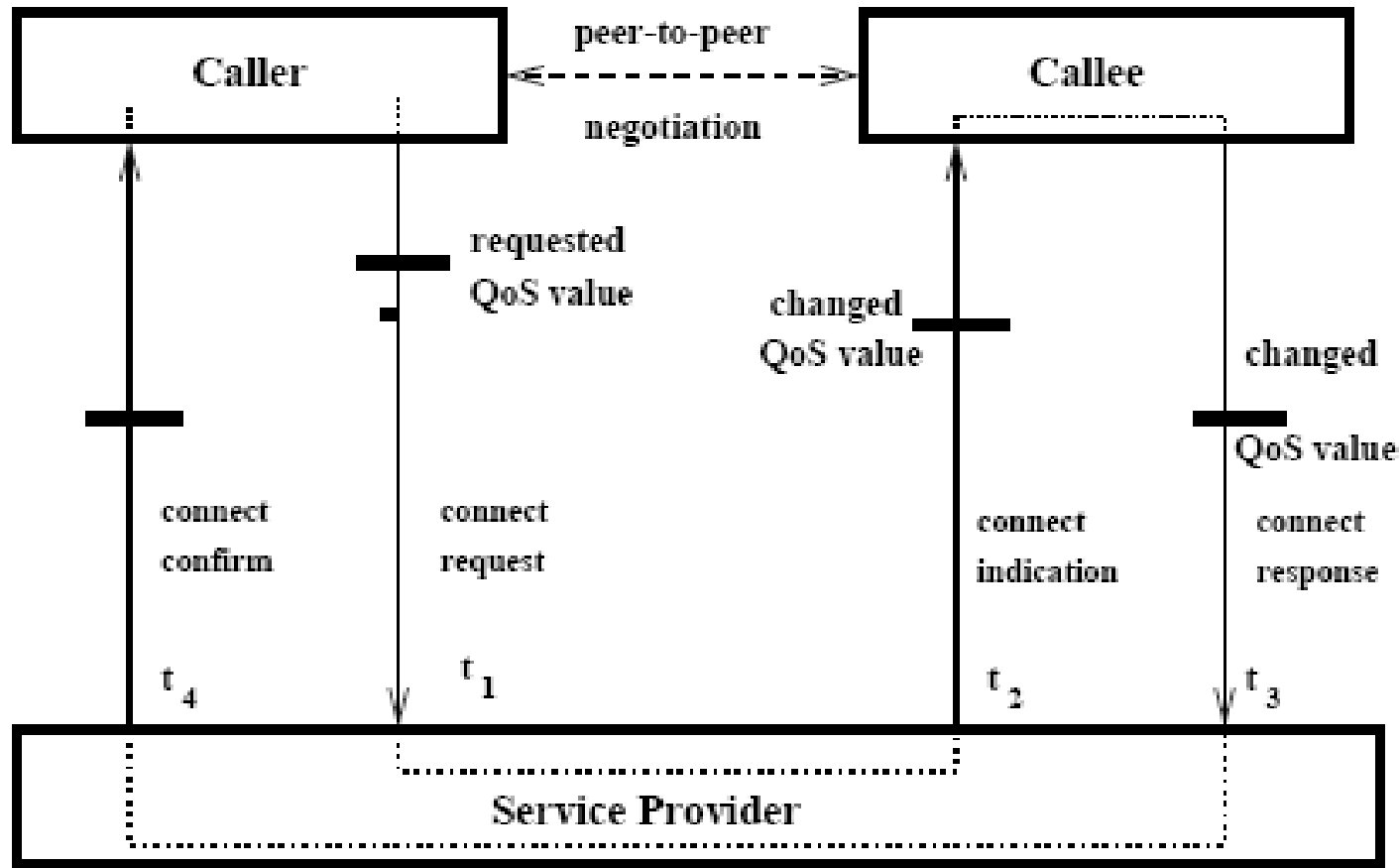
Different Types of Negotiation Protocols

- Bilateral Peer-to-Peer Negotiation
 - Negotiation of QoS parameters between equal peers in the same layer
- Triangular Negotiation
 - Negotiation of QoS parameters between layers
- Triangular Negotiation with Bounded Value

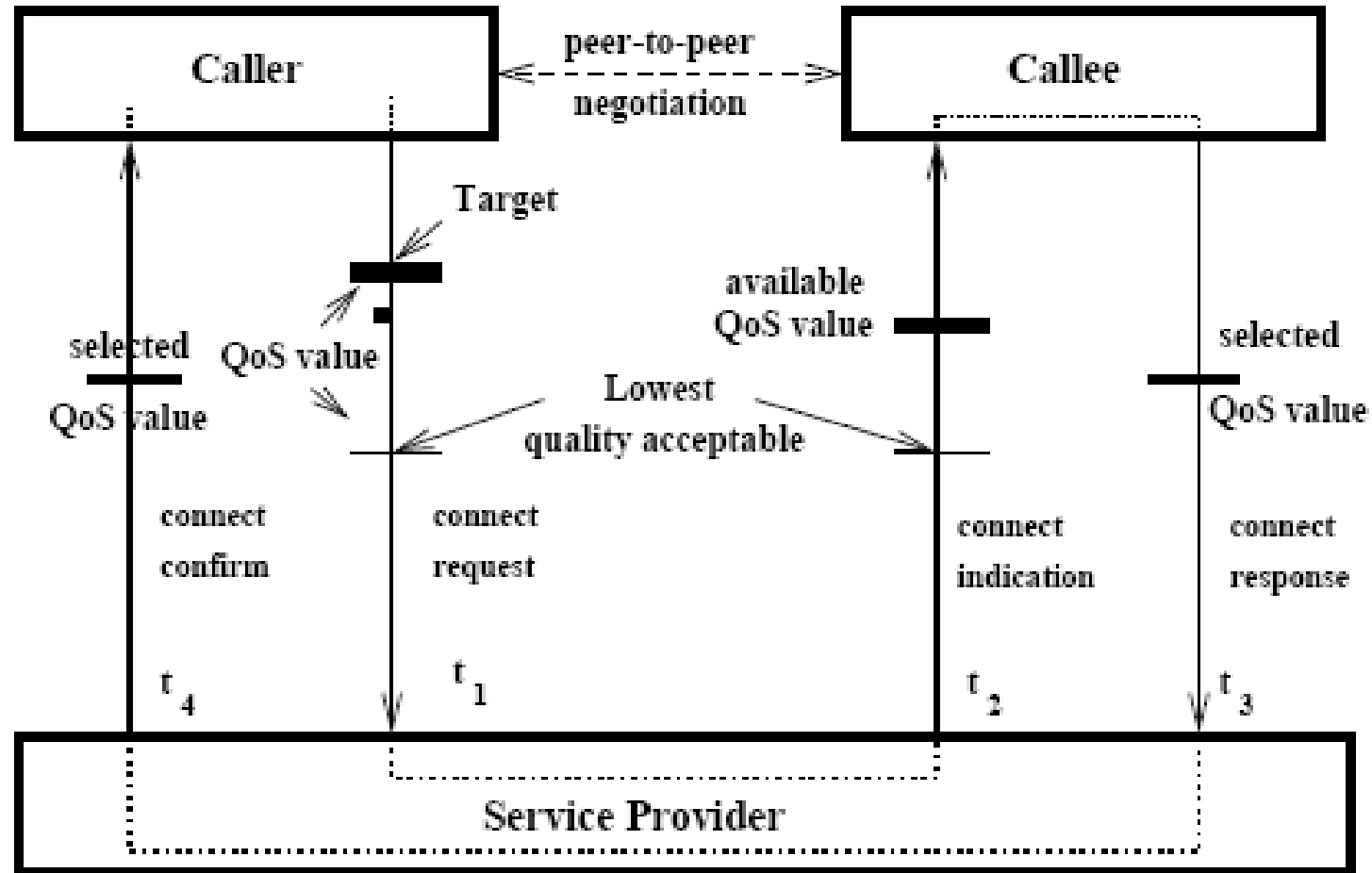
Bilateral QoS Negotiation



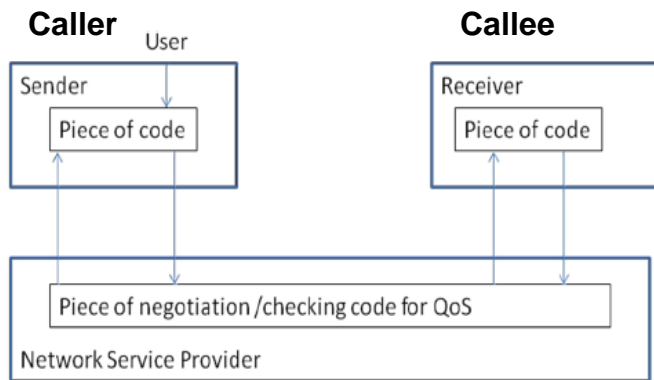
Triangular QoS Negotiation



Triangular Negotiation with Bounded Value



Triangular Negotiation Protocol (Pseudo-Code Example)



Caller Pseudo-Code

```
get-from-user(minQoS, desiredQoS);
send-request-to-service-provider(minQoS, desiredQoS, peer-destination);
wait-for-response-from-service-provider(answer, targetQoS);
if (answer==reject) then let user know about the rejection;
if (answer==accept) && (targetQoS >=minQoS), then negotiateQoS:= targetQoS;
```

Network-Service Provider Pseudo-Code

```
get-from-caller(minQoS, desiredQoS);
//check minQoS and desiredQoS against its own capability (availableQoS),
what QoS the network provider can provide;
if availableQoS < minQoS then
{ send-response-to-caller(reject,0);
  exit();
}
if availableQoS >=minQoS then
{ desiredQoS:= availableQoS;
  //reserve the resources for available QoS;
  send-request-to-callee(minQoS, desiredQoS, peer-destination);
}
wait-for-response-from-callee(answer, targetQoS);
if (answer == reject) then
{ //release reserved resources for available QoS;
  send-response-to-caller(reject,0);
}
if (answer == accept) then
{ //allocate the resources for target QoS;
  send-response-to-caller(accept, targetQoS);
}
```

Callee Pseudo-Code

```
get-from-network-provider(minQoS, desiredQoS);
// check(minQoS, desiredQoS) against its own resources;
if availableQoS < minQoS then
{ send-response-to-network-provider(reject,0);
  exit();
}
if availableQoS >=minQoS then
{ targetQoS:=availableQoS;
  send-response-to-network-provider(accept, targetQoS);
}
```

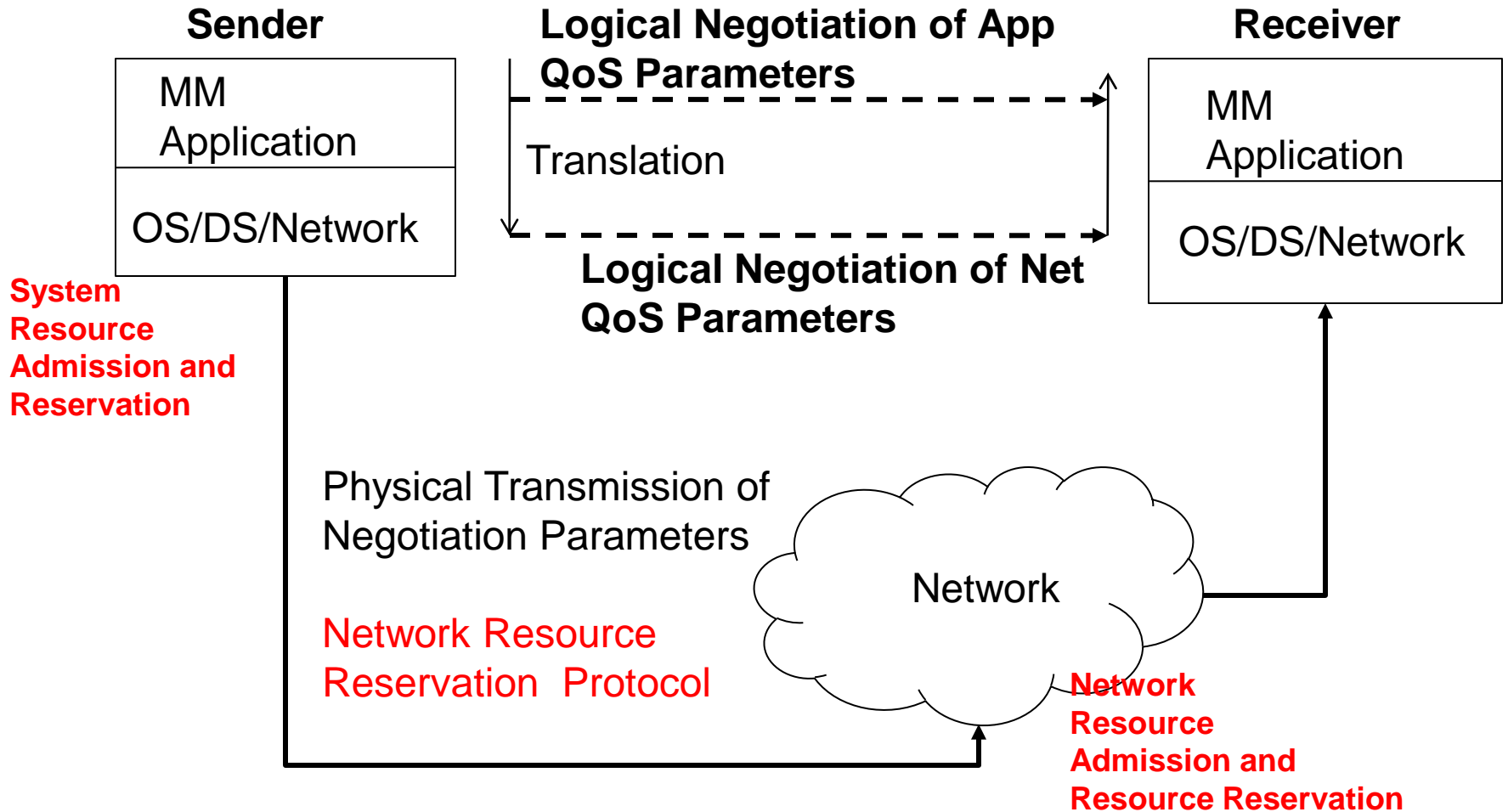
Multimedia Resource Management

- **Resource managers** with operations and resource management protocols
 - Various operations must be performed by resource managers in order to provide QoS
- **Phase 1: Establishment Phase (resource operations)**
 - Operations are executed where schedulable units utilizing shared resources must be admitted, reserved and allocated according to QoS requirements
- **Phase 2: Enforcement Phase**
 - Operations are executed where reservations and allocations must be enforced, and adapted if needed

Phase 1: Resource Preparation Operations

- QoS to Resource Mapping
 - **Need translation or profiling** (e.g., how much processing CPU cycles, i.e., processing time, it takes to process 320x240 pixel video frame)
- Resource Admission
 - **Need admission tests** to check availability of shared resources
- Resource Reservation
 - **Need reservation** mechanisms along the end-to-end path to keep information about reservations
- Resource Allocation

Phase 1: Connection Establishment



Admission Tests

- **Task (System) schedulability tests** for CPU resources
 - This is done for delay guarantees
- **Network Packet schedulability tests** for sharing host network interfaces, network switches
 - This is done for network delay and jitter guarantees
- **Spatial tests** for memory/buffer allocation
 - This is done for delay and reliability guarantees
- **Network Link bandwidth tests**
 - This is done for network throughput guarantees

Resource Reservation and Allocation

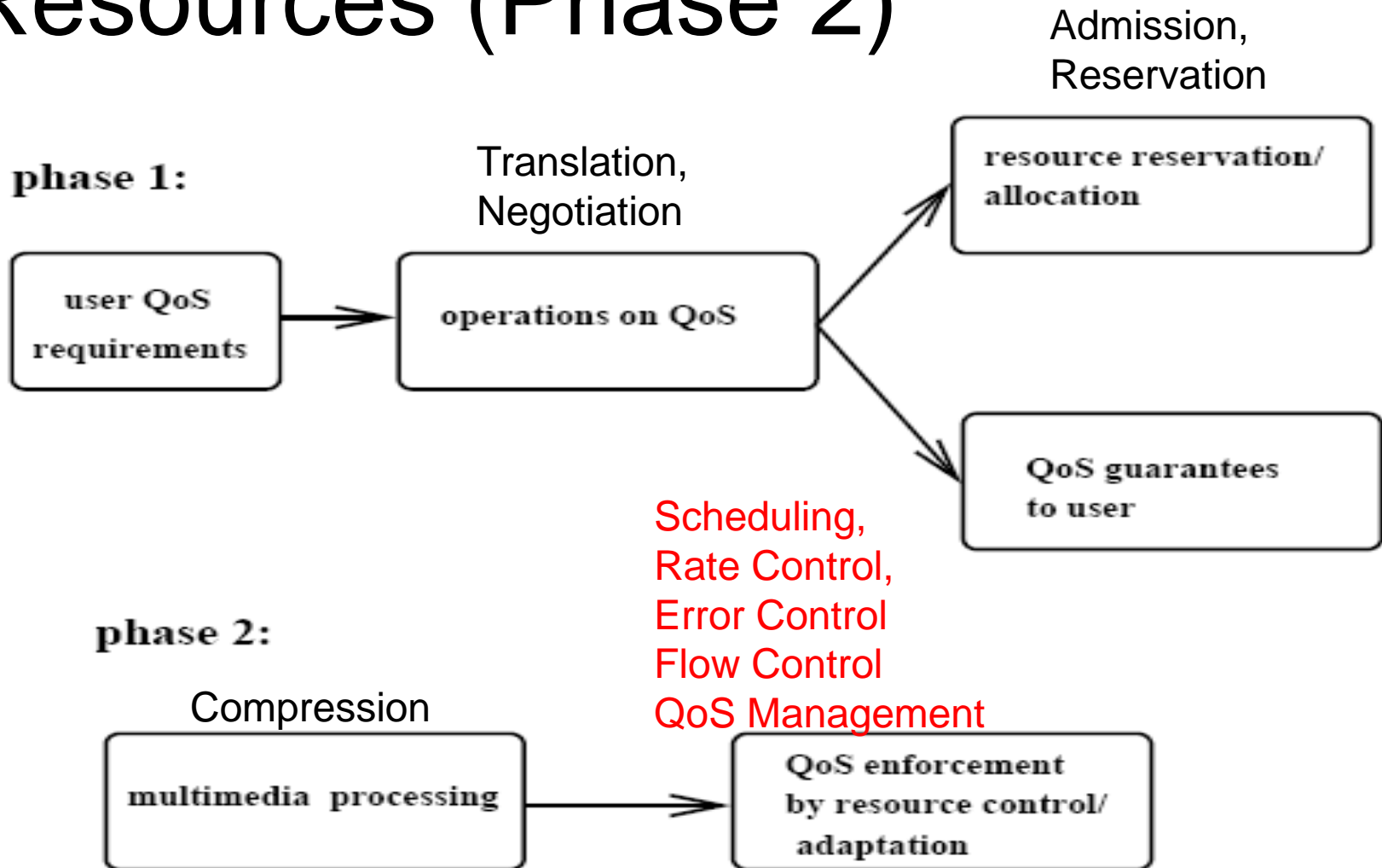
- Two types of reservations
 - **Pessimistic approach** - Worst case reservation of resources
 - **Optimistic approach** - Average case reservation of resources
- To implement resource reservation we need:
 - **Resource table**
 - to capture information about managed table (e.g., process management PID table)
 - **Reservation table**
 - to capture reservation information
 - **Reservation function**
 - to map QoS to resources and operate over reservation table



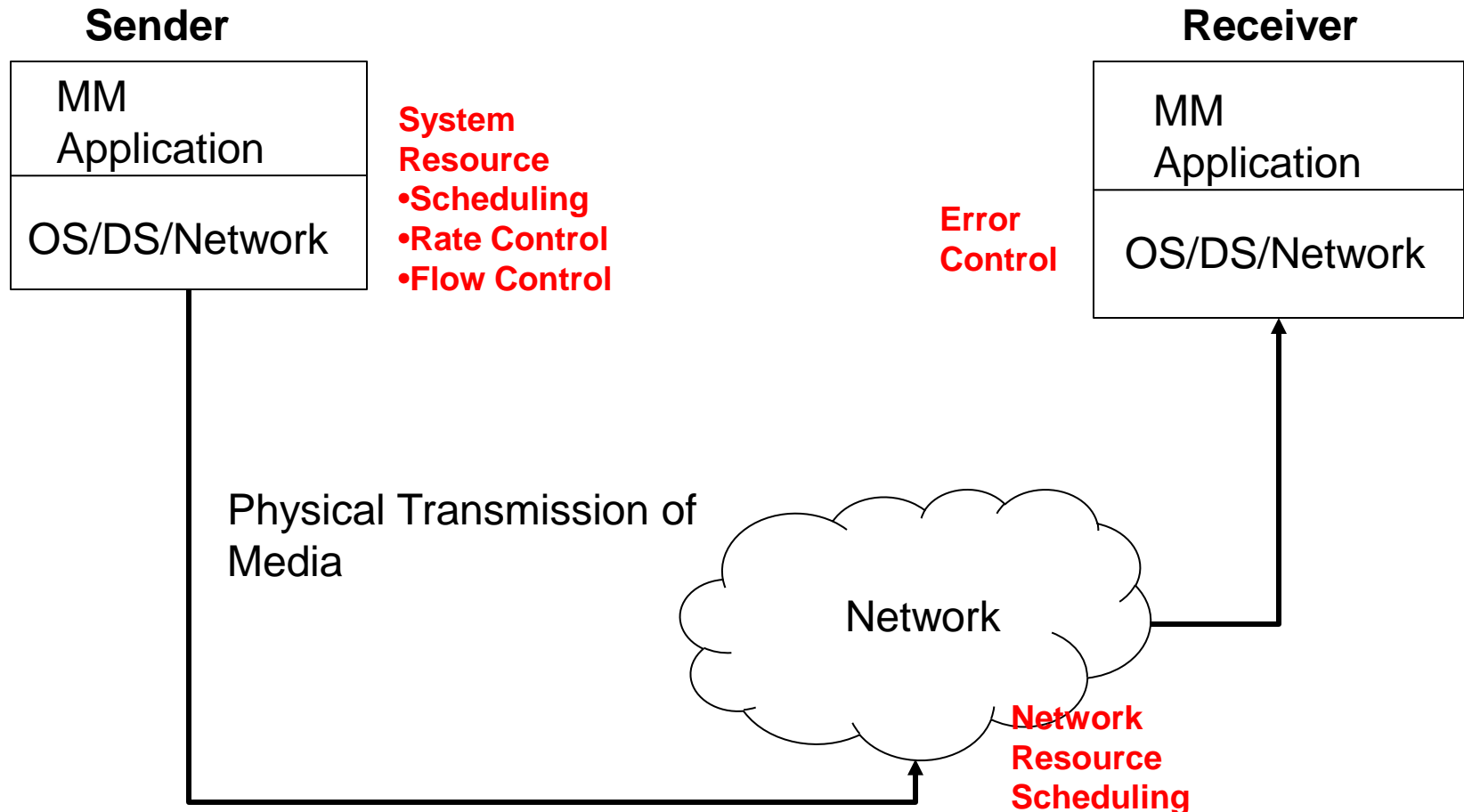
Resource Reservation

- Two types of reservation styles:
 - Sender-initiated reservation
 - Receiver-initiated reservation

Relation between QoS and Resources (Phase 2)



Phase 2: Media Processing and Transmission



Phase 2: Enforcement Operations

- **Resource scheduling**
 - Example: rate-monotonic scheduling
- **Rate control** – traffic shaping
 - Example: leaky bucket
- **End-to-end error control**
 - Example: forward error correction
- **Flow control**
 - Open loop flow control (no feedback)
 - Close look flow control (with feedback channel)

QoS Management during Transmission Phase

■ Resource and QoS Monitoring

- Flexibility, i.e., monitoring should be turned on/off
- Two types of monitoring
 - User-mode monitoring
 - Network-mode monitoring

■ QoS Maintenance

- Compares monitored QoS with contract QoS

■ QoS Degradation

- graceful degradation needed

QoS Management during Transmission Phase

■ QoS Renegotiation and Signaling

- In case QoS parameters need to change, renegotiation must be initiated

■ QoS/Resource Adaptation

- As a result of re-negotiation request (request for change in quality) adaptation in QoS and resource allocation must happen

QoS/Resource Adaptation

- **Renegotiation** request can come from
 - User
 - Host system
 - Network
- Resource **adaptation**
 - Network adaptation (e.g., dynamic re-routing mechanism)
 - Source adaptation (e.g., temporal scaling with feedback)

Resource De-allocation – Tear-Down Phase

- Reserved Resource must be freed up once multimedia session is over
- **Tear-down process**
 - Sender-initiated closing (release reservation)
 - Receiver-initiated closing (release reservation)

Conclusion – Current State of Art

- Lack of mechanisms to support QoS guarantees
 - Need research in distributed control, monitoring, adaptation and maintenance of QoS mechanisms
- Lack of overall frameworks
 - Need QoS frameworks for heterogeneous environments (diverse networks, diverse devices, diverse OS)